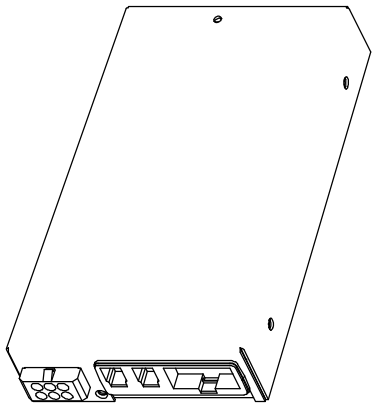
No. 60027, Issue 4. January 1998

DYNAMIC™

DX™ Modular Mobility System

DX Servo Lighting Module (SLM) Installation Manual



Order/Part Number for this Manual : GBK60027 issue 4

Important Notes

1. Read this Manual carefully before installing or operating your DX control system.

2. Due to continuous product improvement Dynamic reserves the right to update this Manual. This Manual supersedes all previous issues which must not continue to be used.

3. Any attempt to gain access to or in any way abuse the electronic components and associated assemblies that make up the wheelchair control system renders the Manufacturer's Warranty void and the Manufacturer free from liability.

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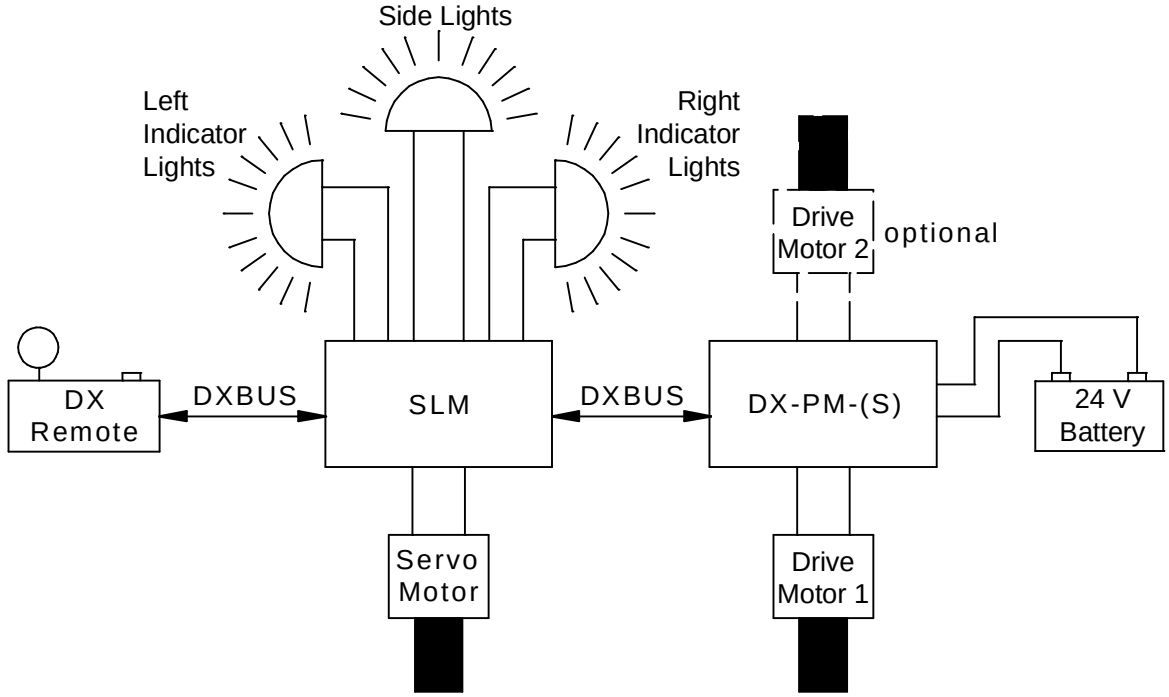
1 Introduction

The Servo Steering and Lighting Module (SLM) controls the steering and lighting for servo steered power wheelchairs. It is part of a DX System also comprising a DX Power Module and a DX Remote as a minimum system.



Example of Minimum DX System with the SLM

The servo wheelchair has one motor for steering, and either one or two motors to provide the driving power of the wheelchair. Both functions are controlled by the DX Remote. If two drive motors are used then a dual channel DX Power Module (DX-PM) is required. If only one drive motor is used then a single channel DX Power Module (DX-PM-S) is required.

The lighting consists of side lights and turn indicators. The indicators can be flashed together to provide a hazard warning. The lights are also controlled by the DX Remote.

The SLM has two standard DXBUS connectors so that it may be connected to the DX System.

This manual and others listed in Section 2 must be read and understood. For more information contact Dynamic Controls Ltd or an agent as listed in section 12.

2 Related Documentation

A DX based wheelchair control system may comprise between two and sixteen DX compatible modules depending on the application. Each DX compatible module has its own Installation Manual which describes the installation requirements of that particular module.

This manual describes the installation of the SLM only and must be read in conjunction with the :

- Relevant DX Remote Installation Manual
- DX Power Module (PM) Installation Manual
- DX Hand Held Programmer (HHP) Manual
- DX Programming Configuration Diagnostic (PCD) Manual
- Installation Manuals for all other DX modules to be used in your system.

3 General Description

The SLM is designed to enable the DX System to run on a servo steered power wheelchair, with lights. The wheelchair will have: a servo motor, a position sense potentiometer, a steering release microswitch, one or two drive motors with integral park brakes, a 24 V battery supply, and optional lights.
There are two versions of the SLM. The SLM utilises 24 V lights while the SLM-TÜV utilises 12 V lights and has an internal voltage regulator.

The DX system will comprise of a minimum of a DX Remote, a DX Power Module, a SLM and may also have up to 13 other DX modules.

The DXBUS is used to control and monitor all DX Modules. The DX Power Module has two identical DXBUS connectors and is connected in a chain type arrangement with the SLM. The SLM can be powered from an independent 24 V power supply, but low power steering requirements can be powered from the DXBUS 24 V supply. The lighting can also be supplied from: the DXBUS, an internal or external regulated 12 V supply, or from the 24 V wheelchair battery. See section 5.4.3 and 5.4.4.

In a servo system the speed and direction data from a DX Remote is passed to the SLM rather than directly to the DX Power Module. The SLM processes the speed data and then sends it directly to the DX Power Module. The direction signal is processed by the SLM and applied to the servo steering motor. A position sense potentiometer tells the SLM the steering position.

A microswitch is attached to the steering clutch so that when the clutch is released for manual wheelchair manoeuvring, the system is inhibited and will not drive. When the clutch is restored, the system must be turned off then on again to drive.

The DX System allows up to five preset Drive Programs to be selected, depending on the type of remote. Each Drive Program contains an associated Steering Program that defines the maximum steering lock available at different speeds, for safe driving. The SLM controls the steering lock to conform to the Steering Program, and also controls the speed output so that the speed can not exceed that allowable for a particular lock.

The SLM can control a full lighting system of side lights (front and rear) and indicator lights (left and right). The activation of the lights is via the DX Remote.

The SLM can be used with a two channel (60 A per channel) DX Power Module (DX-PM) or a single channel 120 A DX Power Module (DX-PM-S). If only one drive motor is used in the system then the DX-PM-S will be used.

3.1 General Features

The SLM has the following general features:

- Servo output capable of supplying 5 A continuous and 30 A peak to a 24 V servo actuator.
- Fully DXBUS compatible.
- Two identical DXBUS sockets for Daisy Chain connection to the DX System.
- Powered by a 24 V wheelchair battery via the DXBUS connection, or directly from the battery for high current applications.
- Fully programmable for optimum driving performance.
- Lighting outputs are TÜV approved when fitted with approved regulated power supply (SLM-TÜV).
- Electromagnetically compatible:
  - not susceptible to high levels of RFI
  - emitting low levels of RFI
  - protected against high levels of ESD.
- Compact case for mounting under the wheelchair seat.

3.2 Safety and Protection Features

The SLM has the following safety and protection features:

- Motor current limit and current limit timeout set to prevent overheating of motors.
- Thermal protection to reduce current limit.
- Short circuit protection of all inputs and outputs except between motor and battery negative while driving.
- Open circuit motor detection when not driving.
- Driving is inhibited if steering clutch is disengaged.
- Over voltage, under voltage and reverse battery protected.

- Detection of broken steering position feedback potentiometer connections or short circuit of the potentiometers` terminals.
- Driving inhibit if Steering Module is not connected and responding.
- Compliance with ISO 7176 requirements.
- Controlled power down in event of DXBUS disconnection or communication failure.
- Hazard lights can be operated by an external switch.
- Hazard lights will operate automatically if communication with the DX Remote is lost while turned on.
- Indicator flash rate will double if a rear indicator bulb has failed.
- Side lights will come on if battery charger is over-charging the batteries or during regenerative braking if the battery cannot absorb the regenerated power.

4 Specifications

4.1 Electrical Specifications

Power Supply Input

Symbol	Parameter	Conditions	Min	Nom	Max	Units
V_{BAT}	Battery voltage		18.0	24.0	32.0	V
I_Q	Quiescent Current	No servo load			150	mA
I_O	Operating Current	+ servo load			250	mA
I_{DXBUS}	DXBUS Current	RMS Continuous to entire system			12	A

Servo Motor + / - Output

Symbol	Parameter	Conditions	Min	Nom	Max	Units
SM+	Output Voltage	When not in current limit	$V_{BAT-1.2V}$		V_{BAT}	V
I_{AV}	Continuous Average Current	Over programmable time period	5			A
Î	Peak Output Current	For up to 5 sec.			30	A

Servo Pot Input / Output

Symbol	Parameter	Conditions	Min	Nom	Max	Units
SP+	Pot Supply + Output Voltage	Open circuit	4.5	5.0	5.5	V
SP-	Pot Supply - Output Voltage			0.0		V
Z_{SP+}	SP+ Output impedance		950	1 K	1050	Ohms
Z_{SP-}	SP- Output Impedance			10		Ohms
Z_{SP}	Acceptable Pot Impedance		4 K	10 K	12 K	Ohms

Steering Clutch Switch

Symbol	Parameter	Conditions	Min	Nom	Max	Units
V_{LO}	Low level switch voltage	Microswitch closed	0		0.5	V
V_{HI}	High level switch voltage	Microswitch open	3.5		5.0	V

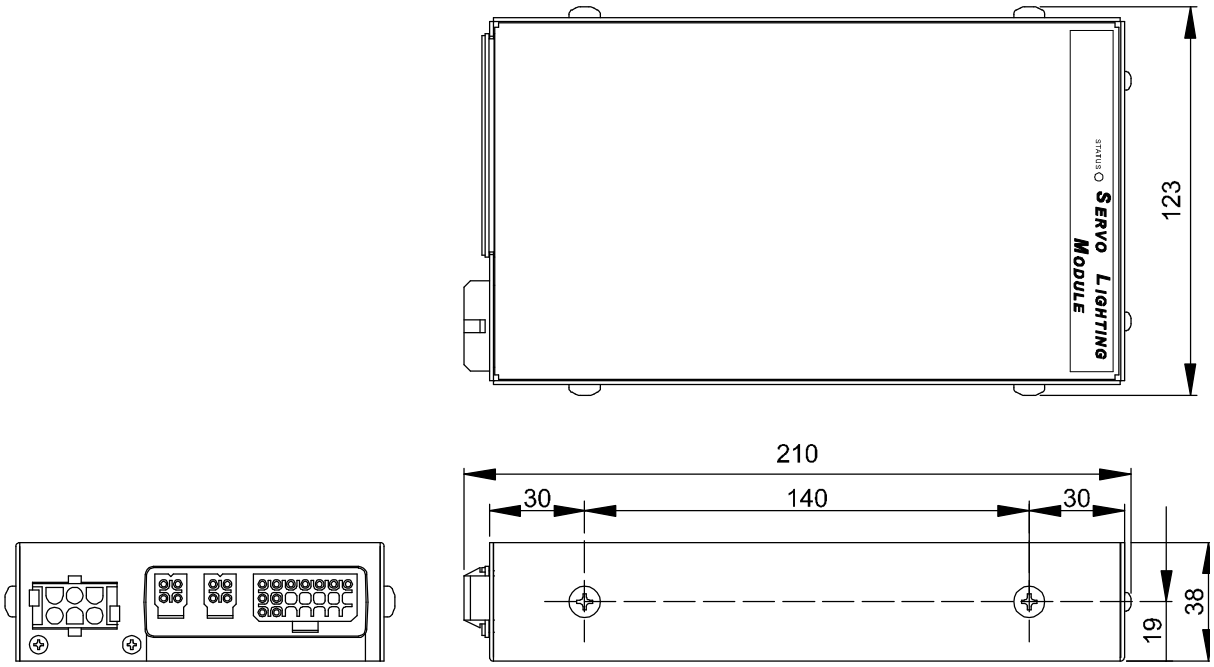
Lighting Specification

Symbol	Parameter	Conditions	Min	Nom	Max	Units
Turn Indicator Outputs (each output)						
V_{TIO}	Output Voltage	13.5 V regulator fitted	13.1	13.5	13.9	V
V_{TIO}	Output Voltage	13.5 V regulator not fitted	V_{BAT-1}	$V_{BAT-0.1}$	V_{BAT}	V
I_{TIO}	Continuous Output Current			2.3	2.5	A
Sidelight (Head / Tail Light) Output						
V_{SLO}	Output Voltage	13.5 V regulator fitted	13.1	13.5	13.9	V
V_{SLO}	Output Voltage	13.5 V regulator not fitted	V_{BAT-1}	$V_{BAT-0.1}$	V_{BAT}	V
I_{SLO}	Continuous Output			2.3	2.5	A
13.5 V Regulated Power Supply (SLM TÜV only)						
V_{REG}	Output voltage	Voltage In 18-32V	13.1	13.6	14.0	V
I_{MAX}	Maximum output current	Max. total lighting load (Note 1)	7.5	9.0	11.0	A

Note 1 The nominal lighting current corresponds to the sidelights and hazard flashing. The supply will current limit at 9 A (nominal) to blow fuses. It is not intended to be used at this level for any extended period of time.

4.2 Mechanical Specifications

Size:	210 * 123 * 38 mm
Weight:	0.530 Kg
Mounting:	M5 screws four places, or placed in tray
Case material:	Aluminium sheet, powder coat finish
Case sealing:	Tamper proof, IP54 if mounted as per mounting instructions



SLM Configuration

4.3 Environmental Specifications

Parameter	Minimum	Maximum	Units
Operating ambient temperature range	-25	50	C
Storage temperature range	-25	70	EC
Operating and storage humidity	0	90	%RH

Electromagnetic Compatibility Specification (EMC)	prEN12184 : 1997 (pending)
Durability	ISO7176 part 14
Vibration Specification	120 minutes @ 4 g's random vibration without damage.

5 Installation

5.1 Introduction

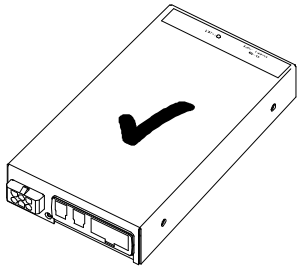
Installing a SLM requires the following steps:

1.	Mounting the SLM	Refer Section 5.2
2.	SLM Connection with the DX system	Refer Section 5.3
3.	SLM 21 Way Connector	Refer Section 5.4
4.	SLM Servo Connector	Refer Section 5.5
5.	Programming the SLM related parameters	Refer Section 7.0

5.2 Mounting

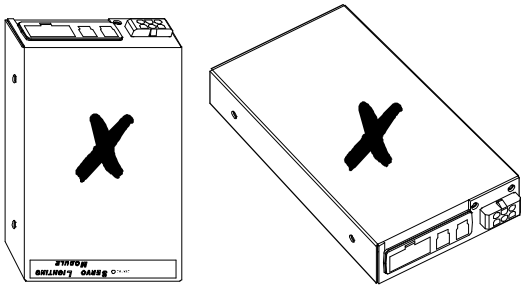
Optimum mounting orientation

Fit the SLM with the top label facing up.



Unacceptable Mounting Orientation

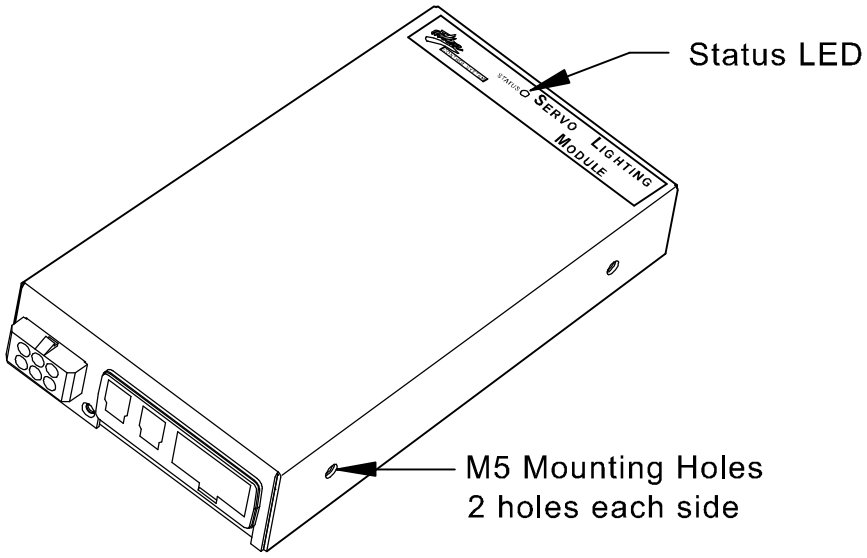
Do **not** mount with connectors facing up.
Do **not** mount with the top label facing down.



Other orientations are acceptable.

Securing the SLM

The SLM can be mounted using the four mounting holes and mounting screws provided, or placed in a suitable tray. Do not use screws which protrude into the SLM case by more than 12 mm.

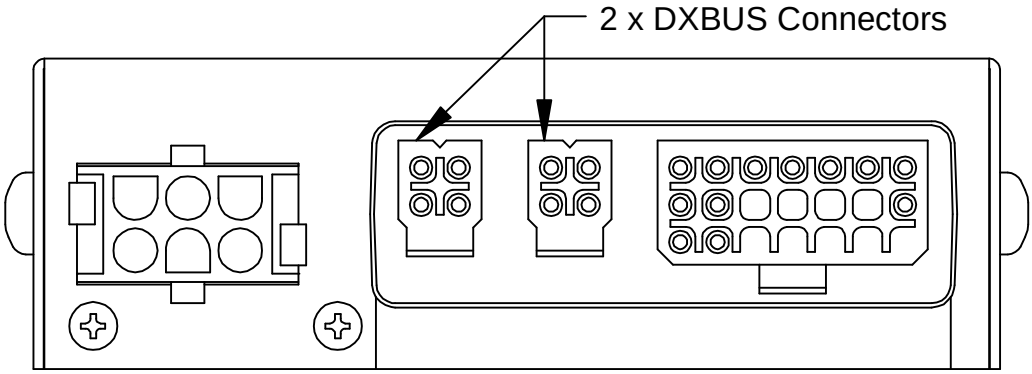


The SLM must be mounted in a position which offers the maximum protection from water and mechanical abuse. Since there are no user accessible controls on the SLM, it can be mounted in a position which is inaccessible to the user e.g. under the seat.

Note For ease of diagnosis, it is recommended that the SLM be mounted where the SLM Status LED can be seen without having to remove covers.

5.3 SLM Connection with the DX System

5.3.1 DXBUS Connections



Note If only one DXBUS connector is used on the SLM and the remaining connector is accessible to the wheelchair user, a dummy DXBUS plug should be fitted to the unused connector. This will comply with ISO 7176.

A dummy DXBUS plug can be made from:

DXBUS Connector Boot	Part/Order Number GCN 0789
DXBUS Connector Housing	Part/Order Number GCN 0792

Like all other DX Modules the SLM is connected to the DX system using the DXBUS. Cables are available in the following standard lengths:

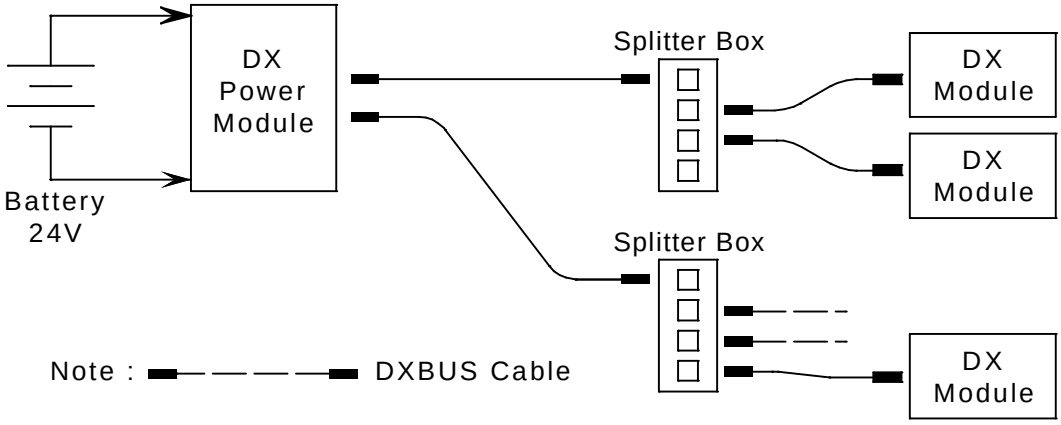
DXBUS CABLE, Straight, 0.1 M	Part/Order Number GSM 63001
DXBUS CABLE, Straight, 0.3 M	Part/Order Number GSM 63003
DXBUS CABLE, Straight, 0.5 M	Part/Order Number GSM 63005
DXBUS CABLE, Straight, 1.0 M	Part/Order Number GSM 63010
DXBUS CABLE, Straight, 1.5 M	Part/Order Number GSM 63015

DXBUS cables are also available with ferrites fitted.

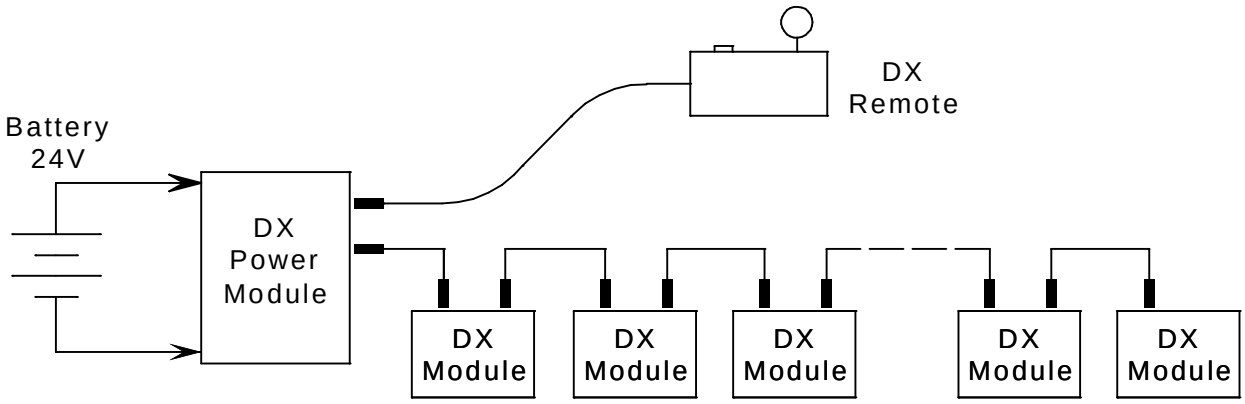
Note The order and positioning of the SLM within the DX system is important and **must** be based on the rules discussed in section 5.3.2 and 5.3.3.

5.3.2 DX Module Interconnection Topology Options

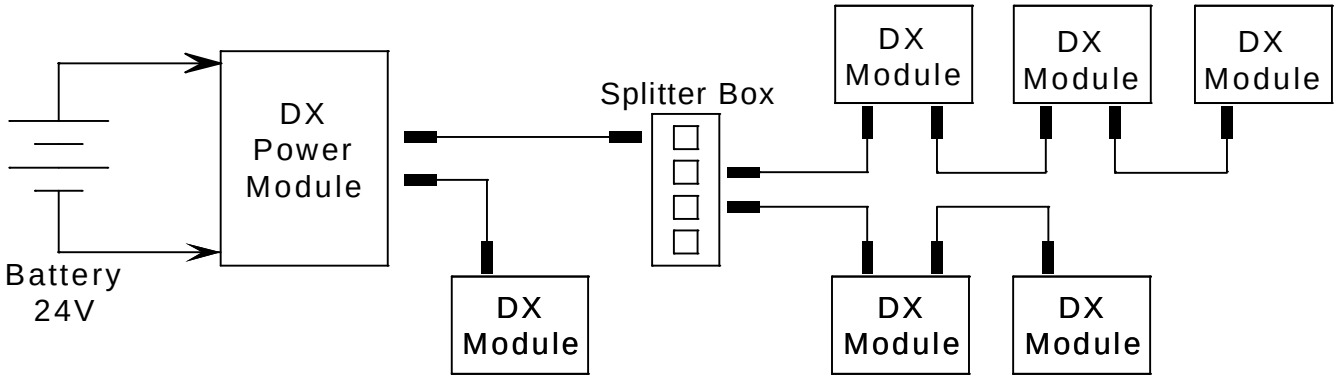
The battery and DX Power Module combination are always considered the heart of a DX system. Other DX Modules can be arranged in several ways:



Star DXBUS Topology



In-line DXBUS Topology



Mixed DXBUS Topology

DX modules normally have one or two DXBUS sockets for system interconnections. Smaller DX modules may have a permanently mounted cable terminated in a DXBUS plug, rather than DX sockets.

The star and mixed topologies both require the use of one or more DX Splitter Boxes. A Splitter Box is a separate panel of four DXBUS sockets that may be purchased from Dynamic or a Dealer.

The DX Splitter Box Part/Order Number is: DX-SKT-X4.

For lowest cost and simplicity the In-line topology is generally preferred, provided the DXBUS length and voltage drop requirements described below can be met.

Warning If the SLM is between the PM and the Battery Charger:

1. Have as few as possible DXBUS cables between the SLM and the PM.
2. The DXBUS cables between the SLM and the PM must not total more than 1 metre.

This will avoid unintended interaction between the SLM and the Battery Charger.

5.3.3 DXBUS Length and Voltage Drop Restrictions

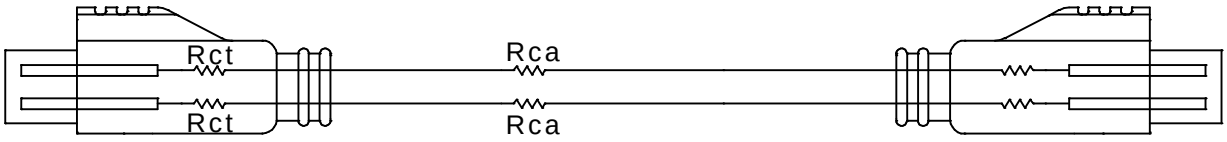
Due to signal distortion that increases with increasing DXBUS length, the total length of all DXBUS cables must not exceed 15 metres in any topology.

Two of the DXBUS's four cores (DXB+ and DXB-) are used to supply power to the modules and to the loads connected to them. A Positive Temperature Coefficient (PTC) device in the Power Module limits the total DXBUS current to 12 A, to protect the DXBUS wiring and connectors. The topology and cable lengths used may reduce the DXBUS's upper limit to below 12 A.

For correct DX System operation the voltage drop on the DXBUS's DXB- wire due to return currents, must not exceed 1.0 V between any two modules within the DX System. Use a topology and module placement that reduces this voltage drop as low as reasonably possible.

Voltage drops occur along the DXBUS due to the return of current back to the battery through the small but finite resistance of the DXBUS cable and connectors.

A DXBUS connector can be modelled as:

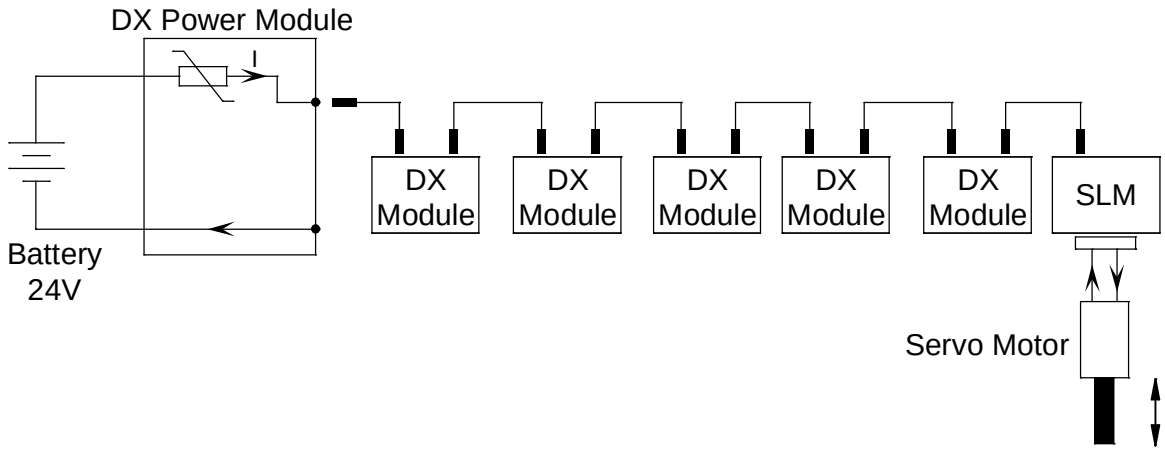


DXBUS Cable Model

R_{ct} = contact resistance = 5 mOhm
R_{ca} = cable resistance = 12 mOhm / metre

Example:

Consider a Power Module connected to an SLM via five other DX Modules using 1 metre cables.



Example of DX Module interconnection

The total resistance of the 0 V return path, between the Power Module and SLM is:

$$6 \text{ X } (_2 * R_{ct} + R_{ca}) = 132 \text{ mOhms}$$

This means that the maximum load that the SLM can drive and not exceed the 1.0 V drop requirement is 1 / 0.132 = 8 A.

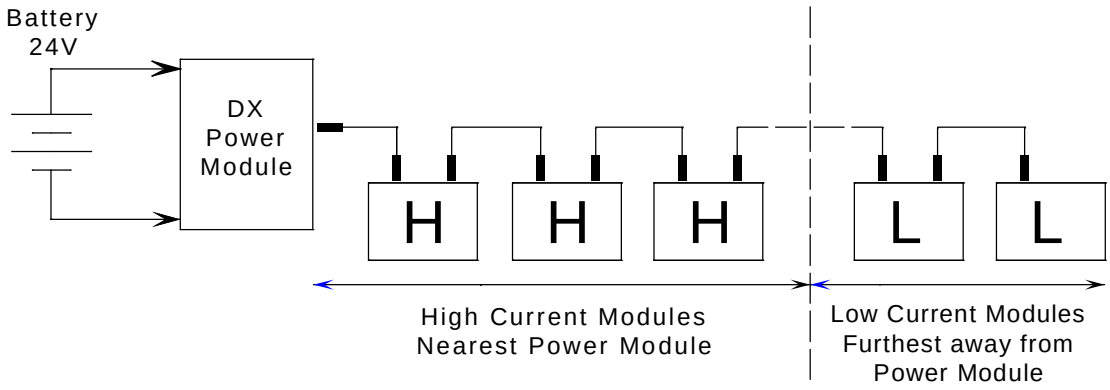
If, for example, the servo motor and lighting that the SLM is required to drive has a peak current of 10 A the interconnection order of the DX modules will have to be changed to place the SLM closer to the Power Module.

The above example illustrates a fundamental rule of DX Module interconnection **All DX Modules that connect to high current loads (e.g. actuators / motors and lights) must be connected as close to the Power Module as possible.**

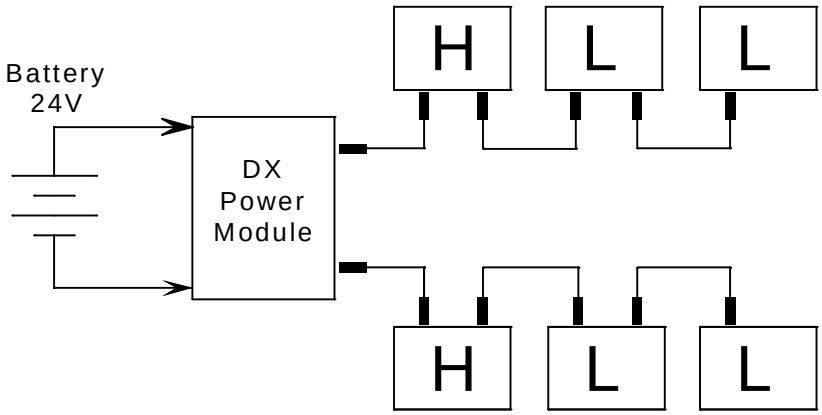
The above example is simplified and does not include current to other DX Modules. The DXBUS maximum current rating of 12 A is for the entire DX System.

Operation of the SLM at its maximum rating of 30 A peak current is not possible from the DXBUS supply. To supply greater than the 12 A DXBUS current, see section 5.4.4.

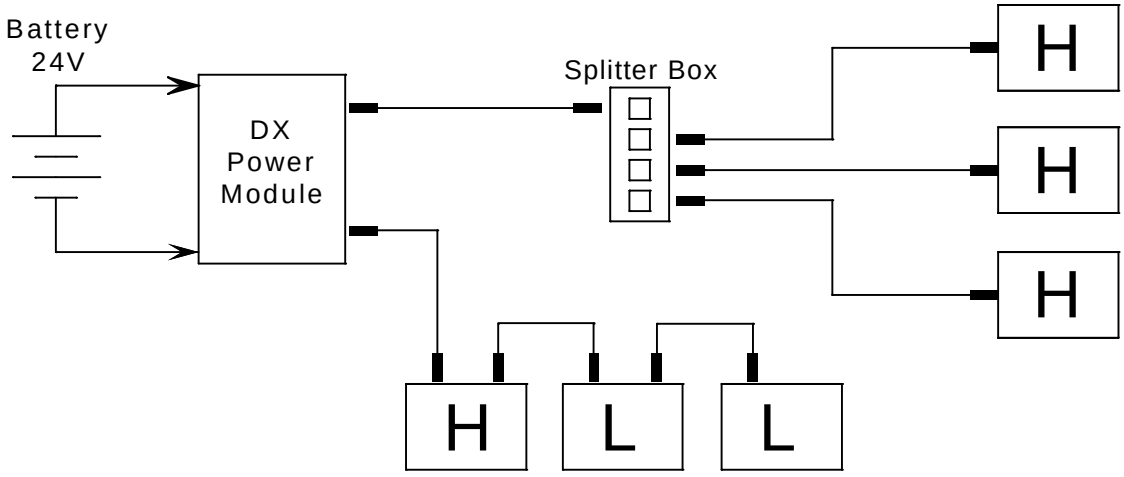
This favours topologies such as:



Rationalised In-line Topology



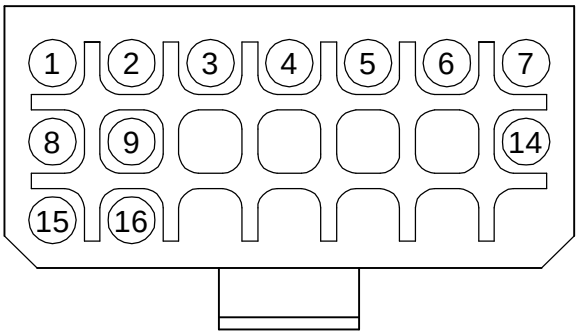
Two way star Topology



Multi Star Topology

5.4 SLM 21 Way Connector

5.4.1 21 Way Connector Pin Definitions



Pin	Function
1	DXBUS -
2	Side Lights -
3	Left Indicator -
4	Right Indicator -
5	13.5 V
6	Hazard In
7	Hazard Out
8	Battery -
9	Steering Power +
14	Battery - (spare)
15	DXBUS +
16	Lighting +

Note : Other pins unused.

5.4.2 21 Way Connector Wires and Terminations

To build a matching connector

To build a matching connector to fit to the 21 way connector, the parts are :

DX 21W Plug Housing	Part/Order Number GCN 0796
DX 21W Boot	Part/Order Number GCN 0795
DX Positronics Contact, FC114N2 (Lge)	Part/Order Number GCN 0793
DX Positronics Contact, FC116N2 (Med)	Part/Order Number GCN 0797
DX Positronics Contact, FC120N2 (Sml)	Part/Order Number GCN 0794

The DX Positronics Contacts are crimp terminals.

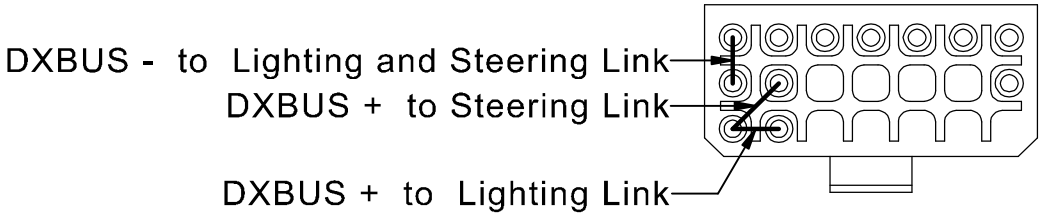
Wire Sizes

The minimum wire sizes that must be used are :

Function	Wire Size (minimum)	Terminal Part
		Positronic Industries Ltd
DXBUS -	1.0 mm²	FC116N2
Side Lights -	0.5 mm²	FC120N2
Left Indicator -	0.5 mm²	FC120N2
Right Indicator -	0.5 mm²	FC120N2
13.5 V	1.0 mm²	FC116N2
Hazard In	0.5 mm²	FC120N2
Hazard Out	0.5 mm²	FC120N2
Battery -	1.0 mm² motors < 10 A	FC116N2
	2.0 mm² motors ≥ 10 A	FC114N2
Steering Power +	1.0 mm² motors < 10 A	FC116N2
	2.0 mm² motors ≥ 10 A	FC114N2
DXBUS +	1.0 mm²	FC116N2
Lighting +	1.0 mm²	FC116N2

5.4.3 Power Supply from the DXBUS

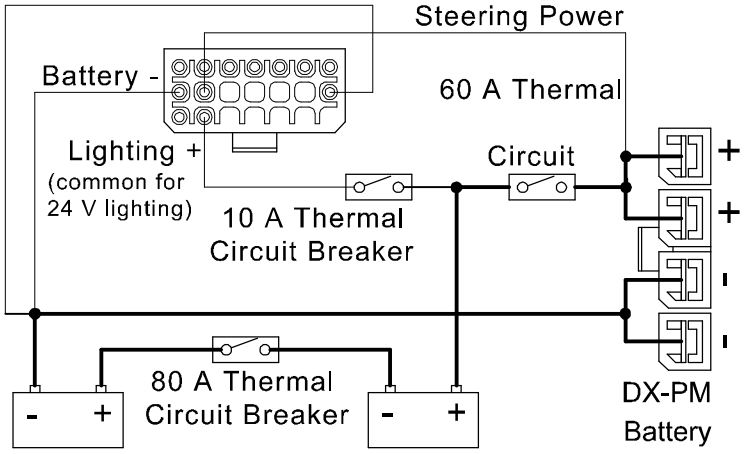
The DXBUS is suitable for powering low speed servo motors and non TÜV lighting, where the DX System current requirement is less than the 12 A DXBUS rating. The DXBUS is not suitable for powering the SLM if TÜV compliance is required.



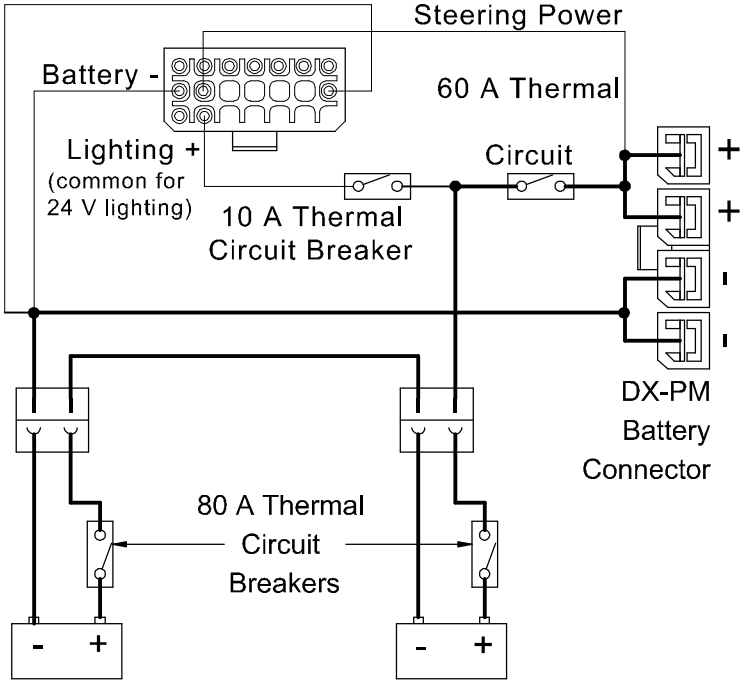
To power the lighting and servo motor from the DXBUS, links must be inserted to short the DXBUS - pin to the Battery - pin, and the DXBUS + pin to the Steering Power and Lighting + pins.

5.4.4 Power Supply from the Battery

When the servo motor and lighting require more current than the 12 A DXBUS current rating has available, the SLM must be powered directly from the battery. Both battery negative terminals on the SLM must be used to achieve TÜV compliance.



(a) Single Battery Box



(b) Dual Battery Box

Note Heavy lines denote 3 mm² or heavier wire. All other wires from the 21 way connector as specified in section 5.4.2.

Thermal circuit breakers must be installed in the battery wiring to protect the batteries, wiring loom and SLM from external short circuits. If the two batteries are permanently wired together (single battery box), the best position for this circuit breaker is between the two batteries. If the batteries are individually plugged together (separate battery boxes), each battery requires a circuit breaker. Separate lighting and driving circuit breakers are used, so that a fault which causes a circuit breaker to operate, will not disable both lighting and driving.

Battery - has two connections to the SLM. This is to ensure that a break in one battery will not disable driving or lights.

Battery Type

The DX System is designed to perform optimally with either Lead-Acid or Gel Cell deep cycle batteries. Consult Dynamic Controls for other battery types. It is recommended that two 12 V batteries with capacity greater than 20 A hours be used.

5.4.5 SLM Connection to Lights

There are three lighting outputs : Pin 2 Side Lights -
Pin 3 Left Indicators -
Pin 4 Right Indicators -

The Side Light Output

This output is used to power head and tail lights. Multiple bulbs can be connected to the output in parallel, as shown in the following diagram. The output is active pull-down when the light is turned on.

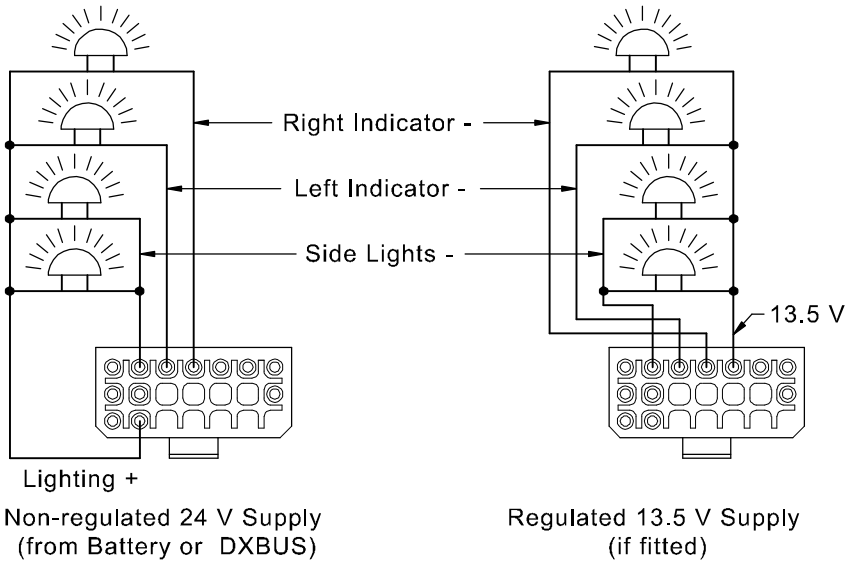
The Left and Right Indicator Outputs

These outputs are also active pull-down when the light is turned on. Again, multiple bulbs can be connected to each output.

Power Source

Wiring of the lights is dependant on the source of the power. When the regulated 13.5 V Power Supply is fitted (SLM-TÜV), the lights are wired to Pin 5. When not fitted (SLM), the lights are wired to Pin 16.
For convenience, the standard SLM which has no such regulator, has Pin 5 connected to Pin 16 internally. This allows the lights to be wired to Pin 5.

Pin 16 supplies the power to operate the lighting control circuits and also the 13.5 V regulator if fitted.

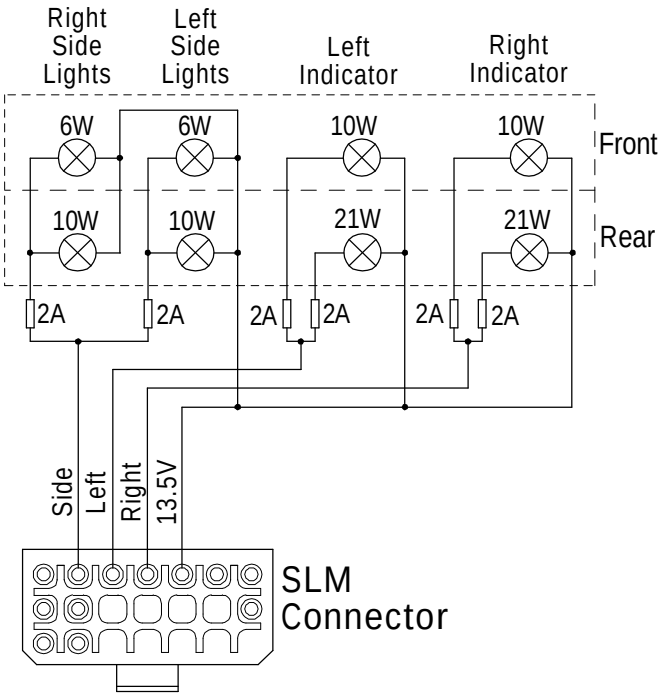


Example of Lighting Wiring

SLM-TÜV Lighting Connections

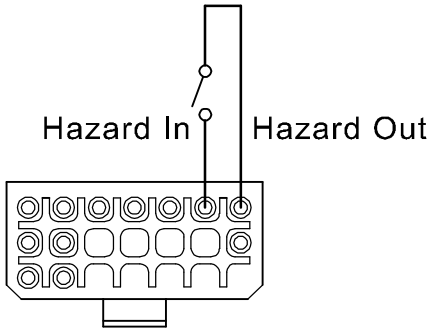
The three lighting outputs are: Pin 2 Side Lights
Pin 3 Left Indicators
Pin 4 Right Indicators

Note : The SLM-TÜV is designed to blow fuses leading to shorted lamps. When wired as shown, a blown fuse will not prevent other lamps on the same circuit from continuing to operate.



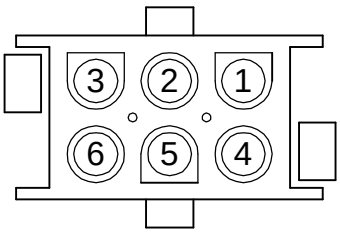
Hazard Switch

An external Hazard Switch can be connected between Pins 6 and 7. When this switch is closed, both indicator outputs will flash synchronously at a rate of 75 flashes per minute.



5.5 SLM Servo Connector

5.5.1 Servo Connector Pin Definitions



front view

Pin	Function
1	Motor -
2	Common Ground
3	Position Sense Pot +
4	Motor +
5	Clutch Switch
6	Position Sense Wiper

5.5.2 Servo Connector Wires and Terminations

To build a matching connector

To build a matching connector to fit the Servo Connector, the parts are :

AMP Mate-N-Lok Connector Housing	AMP Part Number 1-480-704-0 (DCL Part Number GCN 0201)
Amp Universal Mate-N-Lok Contact For 0.5 mm² wires	AMP Part Number 350690-1 (DCL Part Number GCN 0202)
Amp Universal Mate-N-Lok Contact For 1.0 and 2.0 mm² wires *	AMP Part Number 350547 (Solid pin) AMP Part Number 350705 (Split pin)

Wire Sizes

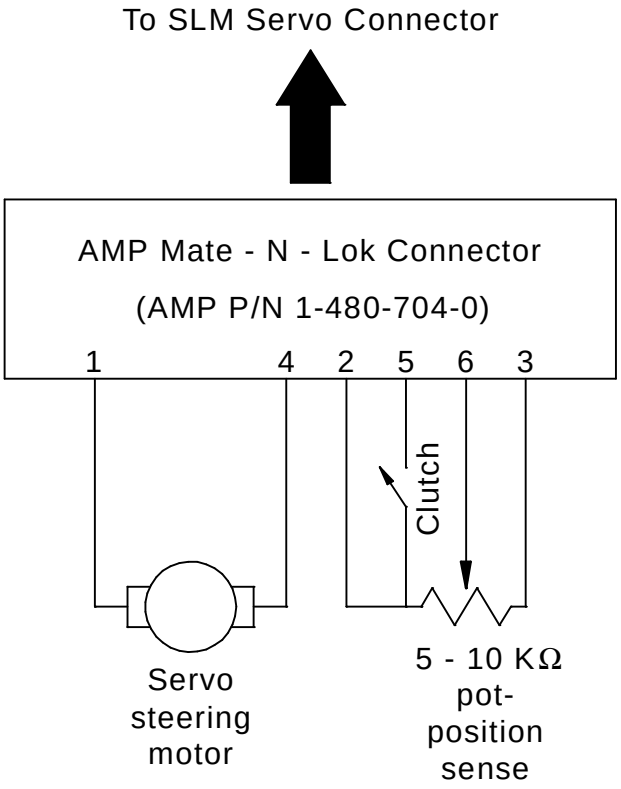
The minimum wire sizes that must be used are :

Function	Wire Size (minimum)	Terminal Part
Motor -	1.0 mm² motors < 10 A	*
	2.0 mm² motors ≥ 10 A	*
Common Ground	0.5 mm²	AMP 350690
Position Sense Pot +	0.5 mm²	AMP 350690
Motor +	1.0 mm² motors < 10 A	*
	2.0 mm² motors ≥ 10 A	*
Clutch Switch	0.5 mm²	AMP 350690
Position Sense Pot Wiper	0.5 mm²	AMP 350690

* AMP Split pin or Solid pin part numbers given above.

5.5.3 SLM Connection to Servo Devices

When the steering wheels are centred, there should be equal resistance between the Position Sense Pot wiper and each end of the pot. Small differences can be overcome during calibration (refer to the Programming section).



The motor wiring should be such that when pin 4 is positive with respect to pin 1, the servo motor turns the pot so that the pot wiper (pin 6) is driven towards pot + (pin 3).

6 Operation

6.1 SLM Activation

The SLM is operated by a DX Remote. Each DX Remote has different facilities and not all support a full lighting system. The operation of the lighting is therefore very dependent on what remote it is used with.

Please consult the User Manual for the DX Remote used in your SLM application.

7 Programming

Warning

Incorrect or inappropriate programming of a DX System may put the wheelchair into a dangerous state.
Dynamic Controls accept no responsibility or liability for accidents caused by incorrect programming.
This chapter must be read and understood before attempting to program a DX System containing an SLM.

7.1 Introduction

The driving performance of an SLM is dependant on its programming. An SLM can be adjusted for a particular application and the driving performance defined to suit the requirements of an individual.

The SLM is programmed at the time of manufacture with factory settings defined by the wheelchair manufacturer (OEM) and Dynamic Controls Ltd. Some parameters may be modified later using the HHP, for individual user requirements. If more than one type of wheelchair is to be used by the customer, each wheelchair type may have its own set of optimum settings.

Non module specific programming of a DX System is contained in the PM and DX Remote Installation Manuals. A servo steered DX System with one drive motor, uses a single channel DX-PM-S, a two drive motor system a DX-PM, which are programmed appropriately at the time of manufacture : see the PM Installation Manual.

The DX Remote can access as many as five drive programs which are treated differently in a servo steered DX System. The settings contained in these programs must be selected with reference to this SLM Installation Manual. There are also three lighting parameters that must be set up in the DX Remote program if lighting functions are required.

7.1.1 Adding an SLM to the DX System

Any DX Remote can be used to control either conventional or servo steered DX Systems. While it is possible to edit a conventional wheelchair program to a servo application using the PCD, the complexity of the operation makes it inadvisable. When changing to a servo steered system, select a servo wheelchair program and modify to suit the requirements of the wheelchair type.

Similarly, to change a DX Remote from a servo to a conventional application, select a conventional wheelchair program to edit as required and download to the DX Remote.

7.2 DX Remote PCD Parameters

Note Refer to section 7.4 ‘Using the PCD’ for PCD operating instruction.

Parameters related to the SLM contained in the DX Remote program fall into two categories : lighting parameters and Drive Program parameters.

7.2.1 Lighting Parameters

The lighting parameters must be enabled so that lights will operate (SLM-TÜV).

Parameter	Purpose
Side Lights Enable State yes / no Accessed by : OEM	If set to ‘yes’, sidelights (front and rear) are enabled. If set to ‘no’, there will be no response to a DX Remote sidelight button being pressed (other than a beep for some varieties of remotes).
Indicators Enable State yes / no Accessed by: OEM	As for the Side Lights Enable parameter
Hazard Enable State yes / no Accessed by: OEM	As for the Side Lights Enable parameter

7.2.2 Drive Program Parameters

The DX System supports up to five Drive Programs. The Drive Programs are defined in the DX Remote programming as factory settings specified by the customer. The Drive Programs govern the driving performance of the wheelchair as suitable for different environmental conditions.

The DX Remote Drive Programs are covered in the relevant DX Remote Installation Manual. Three Drive Program Parameters are however treated differently in the servo steered DX System.

Parameter	Purpose
Maximum Turning Speed	The maximum speed available when the joystick is fully deflected left or right.
Range 10 - 100 % Accessed : DCL	The value assigned to Maximum Turning Speed is not a single performance setting, but a pointer to select one of eight Steering Programs : see section 7.3.1. The Steering Programs are defined by the PCD in the SLM wheelchair program. The Maximum Turning Speed value selects a Steering Program as follows : 10 - 49 % selects Steering Program 1 50 - 54 % selects Steering Program 2 55 - 59 % selects Steering Program 3 60 - 64 % selects Steering Program 4 65 - 69 % selects Steering Program 5 70 - 74 % selects Steering Program 6 75 - 79 % selects Steering Program 7 80 - 100 % selects Steering Program 8 The Steering Programs values can be conventionally assigned so that Steering Program 1 causes the slowest possible turning, progressing up to Steering Program 8 causes the fastest possible turning. If this recommendation is followed, Maximum Turning Speed appears to have the same affect in a servo steering application as in a conventional system.

Parameter	Purpose
Turning Acceleration Range 10 - 70 % Accessed by : DCL	The rate of response when the joystick is deflected left or right from neutral. A value of 10% gives slow response, 70% gives fast response. This defines the rate at which the SLM attempts to respond to a large increase in steering lock. A small increase in lock demand is approached at the maximum possible acceleration. The lock demand at which this parameter is used is set by the PCD in the SLM wheelchair program by the Turning Accel Pt parameter.
Turning Deceleration Range 15 - 100 % Accessed by : DCL	The rate of response when the joystick is deflected left or right towards neutral. A value of 15% gives slow response, 100% gives fast response. This defines the rate at which the SLM attempts to respond to a large decrease in steering lock. A small decrease in lock demand is approached at the maximum possible deceleration. The lock demand at which this parameter is used is set by the PCD in the SLM wheelchair program, also by the Turning Accel Pt parameter.

Note The Turning Deceleration value is normally set as high or higher than the Turning Acceleration value. An inadequate Turning Deceleration value can result in an unsafe wheelchair condition.

7.3 SLM PCD Parameters

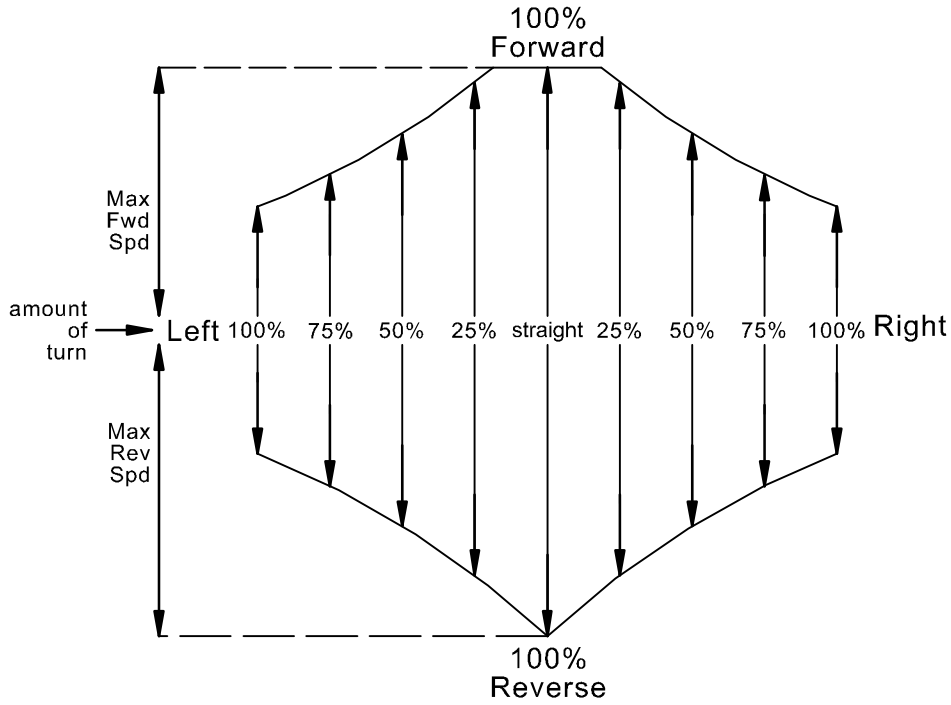
Note Refer to section 7.4 Using the PCD for PCD operating instruction.
Refer to section 7.5 Using the HHP for HHP operating instructions.

7.3.1 Steering Profile Parameters

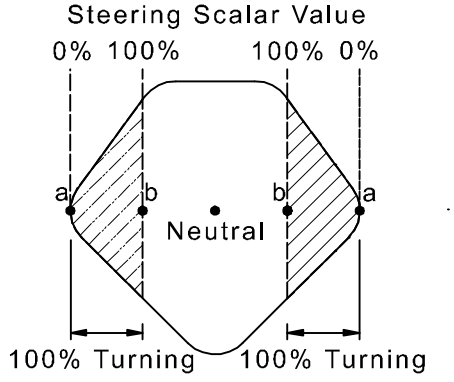
For each of the eight Steering Profiles (Program 1 - Program 8) there are 12 Steering Profile parameters which define the Maximum Turning Speed : see section 7.2.

Parameter	Purpose
	Range (%)
Max Fwd Spd @ 25 Turn	35 - 100
Max Fwd Spd @ 50 Turn	25 - 100
Max Fwd Spd @ 75 Turn	20 - 100
Max Fwd Spd @ 100 Turn	15 - 100
Max Rev Spd @ 25 Turn	35 - 100
Max Rev Spd @ 50 Turn	25 - 100
Max Rev Spd @ 75 Turn	20 - 100
Max Rev Spd @ 100 Turn	15 - 100

Accessed by : Dealer



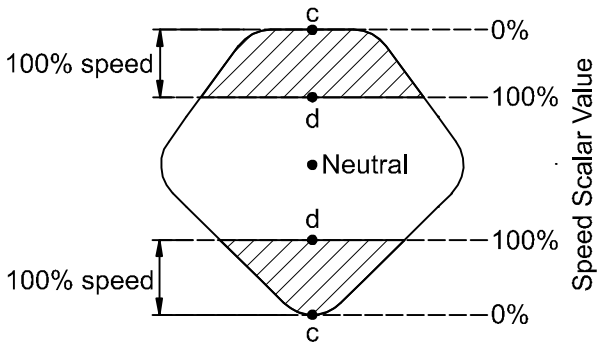
Parameter	Purpose
	The first eight parameters define the maximum forward and reverse speeds for four non-zero turning positions : 25, 50, 75 and 100% turning. The greater +the turning %, the less the assigned speed value should be. It is assumed that a safe speed is the same for left and right turning. Wheelchairs with a lower maximum speed should have higher Max Fwd Spd and Max Rev Spd settings than faster wheelchairs as they are less risk of tipping over. It is reasonable, for slower wheelchairs, to set Max Fwd and Rev Spd @ 25% (and possibly 50%) Turn to 100%. As a general guide: speed at 25% turn should be twice that at 100% turn; speed at 50% turn should be 1.4 times that at 100% turn; and speed at 75% turn should be 1.2 times that at 100% turn. Values are assigned to these eight parameters for each of the eight Steering Profiles. The maximum forward and reverse speeds at zero turning are defined by the standard Drive Program parameters.
Turning Accel Pt Range 0 - 100 % Accessed by : Dealer	Defines the minimum error between the turning demand and the actual turning angle at which the Turning Acceleration and Turning Deceleration parameters apply.
Max Servo Motor Spd Range 10 - 100 % Accessed by : Dealer	The maximum servo motor speed possible. Values are assigned to this parameters for each of the eight Steering Profiles.

Parameter	Purpose
Max Turn @ 100% Speed Range 0 - 100 % Accessed by : Dealer	The purpose of this parameter is to give finer control of the wheelchair when travelling at high speed. The lower the setting, the less sensitive the joystick will be. This also helps reduce the effects of inadvertent joystick movement when travelling over rough terrain. At 100 % speed, the turning angle is limited to the value of this parameter. As the speed reduces, the available turning angle is allowed to increase. The higher the value of this parameter, the higher the speed that the turning angle scaling begins, and the less the turning angle is limited. The lower the value, the lower the speed that the turning angle begins to be scaled, and the greater the limiting of the turning angle. A lower value is suitable for high speed (10 km / h) wheelchairs, and higher values (up to 100%) are suitable for slower wheelchairs. Values are assigned to these parameters for each of the eight Steering Profiles.
Steering Scalar Range 0 - 100 % Accessed by : Dealer	The Steering Scalar value scales the % turning so that 100% turning occurs closer to neutral.  If the Steering Scalar is set to 0%, the joystick must be deflected to point ‘a’ to achieve 100 % turning.

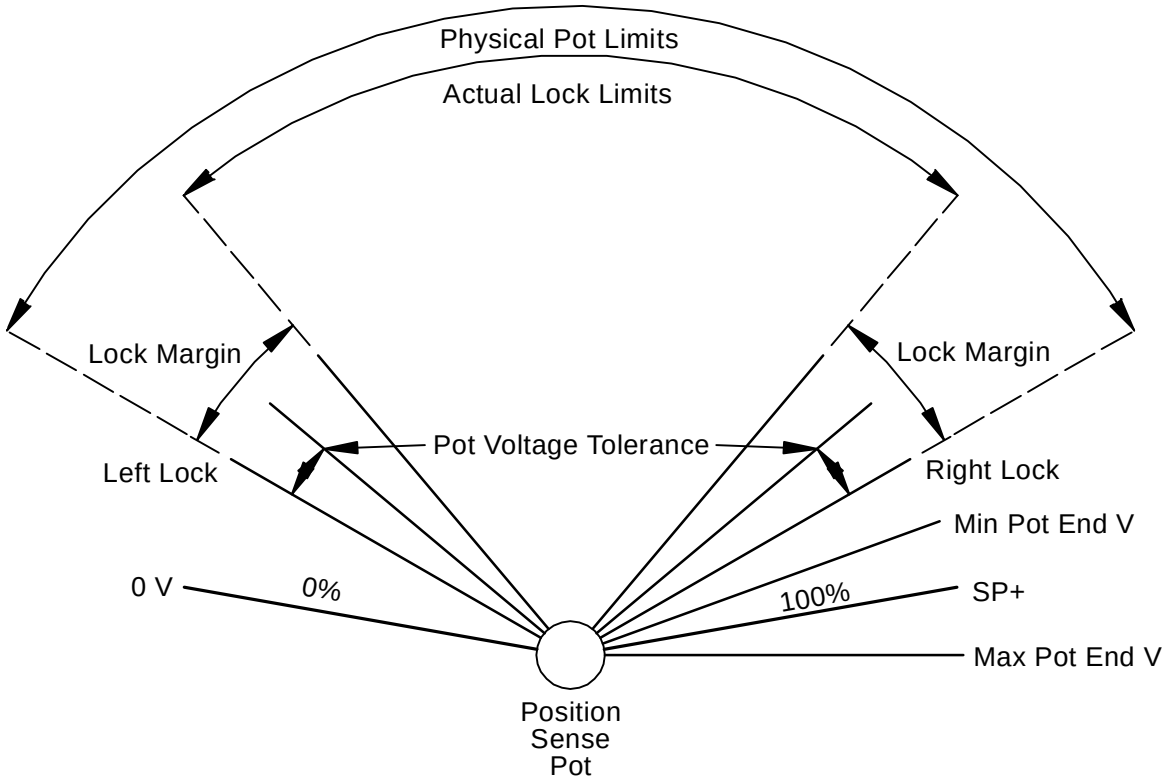
Parameter	Purpose
	A Steering Scalar value of 100% will double the % turning so that 100% turning will occur at point 'b', mid way between neutral and point 'a'. Further deflection towards point 'a' will not give any increase in turning. A higher value is more suitable for diamond shape joystick restrictor plates, a lower value for square, round or octagonal restrictor plates. The purpose of this adjustment is to allow full lock to be achieved with some wheelchair speed, therefore higher values are more suitable for slower wheelchairs and lower values for high speed wheelchairs.

7.3.2 Other PCD Parameters

Parameter	Purpose
Enable Lighting State en / dis Accessed by : OEM	If set to 'en', lighting functions are enabled. If set to 'dis', there will be no response to a DX Remote lighting button being pressed (other than a beep for some varieties of remotes).
Current Limit Range 4 - 40 amperes Accessed by : OEM	The current limit for the servo motor. The SLM will ensure that no more than the stated current will go through the servo motor.
PM Dir Scalar Range 0 - 100 % Accessed by : OEM	For use with two drive motor DX Systems and compensates for different drive wheel spacing. Determine how much one motor increases and the other decreases in speed when the wheelchair is turning. If this parameter is set to 100 %, the inner drive wheel will have zero speed when turning. This value has no effect when a DX-PM-S is used.

Parameter	Purpose
Squared Dir Output State on / off Accessed by : Dealer / OEM	Set to 'on' if the Power Module (DX-PM) drives a front motor and a rear motor. Set to 'off' if the Power Module (DX-PM) drives a left motor and a right motor. A single channel Power Module (DX PM-S) does not use this parameter.
Speed Scalar Range 0 - 100 % Accessed by : Dealer	The Speed Scalar value scales the speed so that 100% speed occurs closer to neutral.  If the Speed Scalar is set to 0%, the joystick must be deflected to point 'c' to achieve 100 % forward or reverse speed. A Speed Scalar value of 100% will double the speed demand so that 100% speed will occur at point 'd', mid way between neutral and point 'c'. The purpose of this adjustment is to allow full speed to be achieved with some turning deflection.
Veer (right +) Range ± 127 Accessed by : Dealer / User HHP Calibrated	The adjustment of the neutral steering position so that the wheelchair does not veer when the joystick is pushed directly forwards or backwards. The veer adjustment is to correct small offsets in the straight-ahead position of the position feedback potentiometer. Large offsets should be corrected mechanically first. See section 5.5.3.

Parameter	Purpose



Left Lock

Range 5 - 95 %
Accessed by : Dealer / User
HHP calibrated

The ratio of the Position Sense Pot Wiper voltage to the full pot voltage when the steering wheels are moved as far left as is mechanically possible.

A physical limitation calibrated using the HHP - refer to section 7.5.

Right Lock

Range 5 - 95 %
Accessed by : Dealer / User
HHP calibrated

The ratio of the Position Sense Pot Wiper voltage to the full pot voltage when the steering wheels are moved as far right as is mechanically possible.

A physical limitation calibrated using the HHP - refer to section 7.5.

Note: The Left and Right Lock parameters must not both be above nor both be below 50%. Typically one will be around 25% and the other around 75%, so that the total will be around 100%.

Parameter	Purpose
Pot Voltage Tol Range 0 - 50 % Accessed by : DCL	Specifies the tolerance of the Left Lock and Right Lock, in % of total pot travel. If the pot position falls within this tolerance then a Steering Fault (SLM Flash Code 3) is displayed by the SLM (refer to Diagnostics section 8). This value is typically set to half the Lock Margin Value.
Lock Margin Range 0 - 50 % Accessed by : DCL	The lock margin voltage ratio, added or subtracted to Left Lock and Right physical Locks. It should be set so that the SLM will target the positions of maximum steering deflection when the joystick is deflected fully left or right. It must be set higher than the Pot Voltage Tol parameter to avoid an error when the wheelchair is in full left or right lock.

Warning: Setting Max Pot End V too high or Min Pot End V too low may prevent some position sense potentiometer faults being detected.

Max Pot End V Range 3200 - 5000 mV (3.2 - 5V) Accessed by : DCL	The maximum allowable voltage at the + end of the position sense potentiometer. If the voltage exceeds this value, a Steering Fault (SLM Flash Code 3) is displayed by the SLM. A suggested value is 4.75V for a 10K ohm potentiometer. (Refer to Diagnostics section 8)
Min Pot End V Range 3000 - 4900 mV (3 - 4.9 V) Accessed by : DCL	The minimum allowable voltage at the + end of the position sense potentiometer. If the voltage is less than this value, a Steering Fault (SLM Flash Code 3) is displayed by the SLM. A suggested value is 4.3V for a 10K ohm potentiometer. (Refer to Diagnostics section 8)

Parameter **Purpose**

Motor Speed

Range 20 - 5,100 ms
(0.02 - 5.1 sec.)
Accessed by : Dealer / User
HHP calibrated

The time taken for the servo motor to travel the full range from left lock to right lock, and visa versa.
This is calibrated using the HHP.

Motor Damping Factor

Range 0 - 100 %
Accessed by : DCL

The speed of response of the servo motor.

For slow motors this value should be low and for fast motors the damping should be high.

Warning An unsuitably high or low value can make the wheelchair unstable.

	Range (%)
Restrict Fwd Spd 25 %	60 - 100
Restrict Fwd Spd 50 %	40 - 100
Restrict Fwd Spd 75 %	20 - 100
Restrict Fwd Spd 100 %	0 - 100
Restrict Rev Spd 25 %	60 - 100
Restrict Rev Spd 50 %	40 - 100
Restrict Rev Spd 75 %	20 - 100
Restrict Rev Spd 100 %	0 - 100

Accessed by : Dealer / User
HHP calibrated

The maximum forward and reverse speeds for four non-zero lock positions : 25, 50, 75 and 100 % turning lock.

The physical restrictor plate fitted to the DX Remote is calibrated with these parameters, using the HHP.

If the DX Remote is replaced, these parameters must be recalibrated.

Plate parameters are grouped and calibrated in one operation of the HHP.

Parameter **Purpose**

Stall Time

Range 5 - 50 seconds
Accessed by : DCL

The stall timeout delay. If the current limit is exceeded for more than this time a Stall Timeout Fault (SLM Flash Code 11) will be displayed by the SLM (refer to Diagnostics section 8).

Stall Timeout

State yes / no
Accessed by : DCL

If set to 'yes', driving is disabled after Stall Time if in current limit.

A Stall Timeout Fault (Flash Code 11) is displayed by the SLM (refer to Diagnostics section 8).

I²T

State on / off
Accessed by : DCL / OEM

If set to 'on', motor I²T is enabled.

I²T parameters define the thermal characteristics of the motors used in wheelchair.

The OEM must provide sample motors or detailed motor specifications to Dynamic Controls Ltd. Dynamic will provide recommended setting to ensure correct motor protection against overheating.

I²T Threshold

Range 10 - 90 %
Accessed by : DCL / OEM

I²T parameter, see above.

Motor Time Scale

Range 10 - 200
Accessed by : DCL / OEM

I²T parameter, see above.

Max Motor Temp

Range 70 - 200 EC
Accessed by : DCL / OEM

The maximum motor temperature used for I²T protection of the motor.

I²T parameter, see above.

Parameter	Purpose
High Voltage Roll/b Start Range 24 V - 33 V Accessed by : DCL	Above this battery voltage, the wheelchair speed will be progressively reduced. The purpose is to reduce excessive battery voltage when the wheelchair is driven down a slope. When the battery voltage exceeds this voltage, the SLM will automatically turn on the side lights to prevent the battery being over charged. **Note** A value of 29 V or greater is recommended to avoid the side lights coming on when the battery is charging.
High Voltage Roll/b End Range 28 V - 33 V Accessed by : DCL	Above this battery voltage, no driving speed will be available. This value should be greater than the High Voltage Roll/b Start value.
Waggle Time Range 20 - 5100 ms (5.1 sec.) Accessed by : DCL	The time taken to perform (and thereby the severity of) the Waggle Test. Refer to the Waggle Test parameter.
Waggle Test State : on / off Accessed by : DCL	If set to ‘on’, a Waggle Test is performed when the DX System is turned on,. This test involves the steering wheels turning one way, then the other, before returning to the original position. If the Straighten at Start parameter is set to ‘yes’, then the wheels will return to the centre position.
Straighten at Start State : yes / no Accessed by : DCL	If set to ‘yes’, the steering wheels will straighten when the DX System is turned on.

Parameter	Purpose
Steer Err Reduce Range 50 - 95 % Accessed by : DCL	Every 20 msec. the voltage at the Position Sense Pot is checked and any error added to a Cumulative steering Error value. Prior to this addition, the Cumulative Steering Error is scaled by the Steer Err Reduce value. The higher the Steer Err Reduce value, the more quickly the Cumulative Steering Error is likely to accumulate. If it goes above a preset threshold (refer to the Steer Err Threshold parameter) a Steering Error (SLM Flash Code 3) is produced (refer to Diagnostics section 8).
Steer Err Threshold Range : 10 - 100 % by : DCL	If the Cumulative Steering Error reaches the Steer Err Threshold, a Steering Error (SLM Flash Code 3) is displayed by the SLM (refer to Accessed Diagnostics section 8).
Steer Clutch Active State : high / low Accessed by : OEM	Set to ‘low’ if clutch input is active low, i.e. input is low if steering disengaged. Set to ‘high’ if clutch input is active high.

7.4 Using the PCD

Programmable parameters relating to the SLM are contained in the DX Remote (UCM Remote) and the SLM programs. These programs can be modified using the PCD (Programming Configuration Diagnostic) tool.

To view and / or edit these parameters:

1. Enter the PCD's Main Menu screen as described in the PCD Manual.

2. Select the "Edit Wheelchair Library" menu option.

3. Select either "Edit Standard Wheelchair Program" or "Edit Custom Wheelchair Program" where appropriate.

4. Select the chair program that you wish to view or edit.

5. Select the "Edit Module Parameters" menu option.

6. Select "SLM" or "UCM Remote".

7. Scroll through the list of parameters. See sections 7.2 and 7.3 for the list of parameters that require programming and their functions. Adjust parameters as required.

8. Press 'ENTER' to accept the changes or 'ESC' to exit without saving. Select "Write Program to Library" option and press 'ENTER'. These values will now be part of the Standard Wheelchair Program for this type of wheelchair and be automatically downloaded to the DX Remote and the SLM when using the "Program Wheelchair" option.

7.5 Calibrating the SLM using the HHP

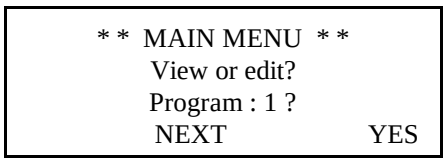
There are twelve SLM parameters that must be calibrated to the individual wheelchair system using the HHP. These parameters are all described in section 7.3.

The first four parameters calibrated by the HHP are approached sequentially. The eight Restrictor Plate parameters are grouped and calibrated in one operation of the HHP.

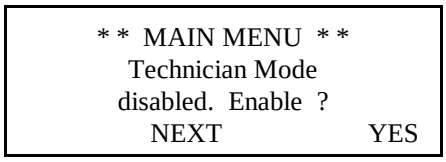
7.5.1 Initial Operation

1. Plug HHP into the Programmer Socket on the DX Remote and turn the DX System on. The initial screen appears for two seconds.

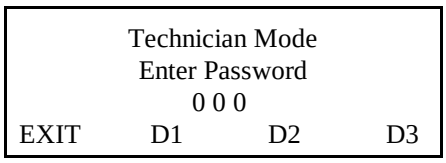
2. Then the main menu screen reads :



3. Press 'NEXT' until the Technician Mode screen appears :

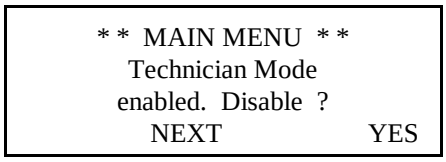


4. Press 'YES' and a screen will appear to enter the three digit password.



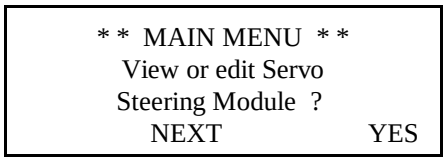
Press the D1, D2 and D3 buttons to cycle each digit through to the correct password. When the password reads correctly, press the 'EXIT' button.

5. The screen now reads :



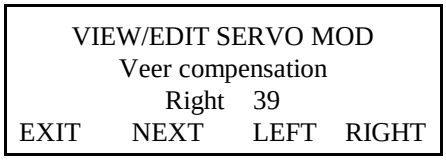
Step four toggles this screen between Technician Mode Enabled to Technician Mode Disabled.

6. Press 'NEXT" until the screen reads :



Press 'YES'.

7. Press 'YES'. The display reads:



7.5.2 Calibrating Parameters

Pressing ‘EXIT’ at any point during the calibration procedure will return you to screen ì .

1. Calibrate the **Veer Compensation** (Veer (right +)) Parameter.

í

VIEW/EDIT SERVO MOD			
Veer compensation			
Right 39			
EXIT	NEXT	LEFT	RIGHT

Press 'LEFT' and ‘RIGHT’ to adjust the value. The range is ± 127.

Selecting the correct value will require experimentation. When calibration is completed test drive the wheelchair. Select a Veer Compensation value so that the wheelchair does not veer when the joystick is pushed directly forwards or backwards. If the wheelchair veers right, press ‘LEFT’; if the wheelchair veers left, press ‘RIGHT’.

If a large compensation value is required, the mechanical position of the position sense potentiometer may require adjustment - see section 5.3.3.

2. Calibrate the **Right Lock** Parameter. The range is 0 - 100 %.

VIEW/EDIT SERVO MOD			
Right Lock			
84%			
EXIT	NEXT	UP	DOWN

Press 'UP' and ‘DOWN’ until steering wheels are moved as far right as is mechanically possible. Press the HHP buttons slowly and firmly, and pause between each press.

Press ‘NEXT’.

3. Calibrate the **Left Lock** Parameter as per the Right Lock Parameter.

4. Calibrate the **Motor Speed** Parameter.

VIEW/EDIT SERVO MOD		
Max motor speed calibration		
EXIT	NEXT	START

Press 'START'. The steering wheels move to left and right extremes, then return to centre.

Press ‘NEXT’.

This calibration should be performed with the normal weight on the chair i.e. while sitting on the chair.

5. Calibrate the **Restrictor Plate** (Restrict Fwd/Rev Spd) Parameters.

This procedure calibrates the speed for four forward and four reverse turning positions.

VIEW/EDIT SERVO MOD		
Restrictor plate calibration		
EXIT	NEXT	START

Press 'START'.

VIEW/EDIT SERVO MOD	
Trace joystick outline	
EXIT	SAVE

Move the joystick around the outer physical extremities of the restrictor plate. Ensure that all corners are pressed into.

Press ‘SAVE’ to return to the previous screen.

6. Press ‘NEXT’ to return to í or if calibration has been completed, press 'EXIT' to return to ì, then ‘NEXT’.

Note ‘NEXT’ must be pressed in screen ì so that the calibration settings are saved to both the SLM and the DX Remote.

Unplug the HHP and turn off the DX System.

8 Diagnostics

SLM diagnostics can be examined from two platforms : from the Flash Codes displayed by the SLM (and DX Remote), and from the PCD (Programming Configuration Diagnostic) tool. The PCD can provide more detailed information about the nature of the fault.

8.1 Troubleshooting

- The SLM may not run at all, or operate in an unexpected way, if the programmable parameters are not set up correctly. Using the PCD, examine all the parameters detailed in section 7 to ensure they are correctly set up for your application.

- The side lights may come on while the battery charger is plugged in. This may be caused by:
  1. The Battery Charger may be overcharging or charging at too high a rate.
  2. The SLM is between the Battery Charger and the PM and the DXBUS cables are too long. See section 5.3.2.
  3. The PCD parameter High Voltage Roll/b Start may be set too low.

- Chair starts to veer, but no flash codes are reported.
  1. Mechanical slipping of the body or shaft of the steering position sense potentiometer.
  2. Mechanical slipping of the steering assembly.

  These may not be severe enough to generate a stepping feedback fault but will require mechanical adjustment.

8.2 Flash Codes

Any fault condition on the DX system will cause the DX Remote's System Status LED (generally the Power On indicator) to flash. Flashing occurs in bursts of flashes separated by a two second pause. The number of flashes in each burst is referred to as the **Flash Code** and indicates the nature of the fault.

The SLM also detects faults, which it then conveys to the DX Remote. Flash codes are always displayed on the DX System Status LED but in most cases the SLM will also display a flash code on its Status LED. Some SLM flash codes are just a reflection of the flash code on the DX Remote, while others give additional information. Refer to the table following.

Faults that affect the safety of the wheelchair will cause the wheelchair to stop, while less critical ones will be indicated but allow the wheelchair to continue driving. Some faults will automatically clear when the fault condition is removed (non-latched) while others are latched and must be cleared by turning the DX System off and then on again.

If the suggested action does not remove the fault, contact a Dynamic Sales and Service Centre (refer to section 12).

DX System Status LED Flash Code	SLM Status LED Flash Code	Likely Cause of Fault and Possible Action
1	1	**Module Fault** Cause: Connections between DX Modules may be faulty, or there may be an internal fault in the SLM. Action < Check DXBUS connections and replace where necessary. < Replace SLM. < Consult an approved Dynamic Service Agent
	2	**Motor Fault** Cause: A servo motor fault has been detected. Action: < Check wiring to motor. < Check servo motor for a short or open circuit.

DX System Status LED Flash Code	SLM Status LED Flash Code	Likely Cause of Fault and Possible Action
2	3	**Steering Fault** Cause: The Position Sense Pot is faulty or cannot track the requested steering position. Action: < Check the Pot Shaft is not slipping, or the Pot. Body turning. < Check the Pot For short and open circuits between pins. < Ensure that the clutch is engaged and not slipping. < Ensure that there is no excessive load on the steering system. < Check the servo motor connector and wiring.
		Note: If this problem only occurs when large steering movements are requested, the SLM`s motor speed parameter may need to be recalibrated using an HHP.
2	4	**Lighting Fault** Cause: 1. A fault is detected in the lighting circuits or the internal regulator (if fitted). 2. Indicator lights are flashing faster than Action: < Check the lighting circuitry for shorts and open circuits. < Check side and indicator bulbs.
	5	**Clutch Released** Cause: The clutch switch is or has been in the released position. Action: < Re-engage the clutch if necessary and turn the DX System off then on. < Check the servo motor connector and wiring. < Check the operation of the clutch switch.

DX System Status LED Flash Code	SLM Status LED Flash Code	Likely Cause of Fault and Possible Action
7	7	**Low Battery Voltage Fault** Cause: The battery voltage has fallen below 17 V. Action: < Check battery connections and terminals. < Check fuses have not blown or circuit breakers tripped. < Replace battery if worn out.
9	9	**CANL Fault** Cause: 1.An invalid voltage has been detected on the DXBUS CANL line. 2. Communication is not possible using the CANL wire. Action: < Check the continuity of the DXBUS cable. < Check for shorts between DXBUS pins. An open or short circuit on another DX module can cause this fault.

DX System Status LED Flash Code	SLM Status LED Flash Code	Likely Cause of Fault and Possible Action
10	10	**CANH Fault** Cause: 1. An invalid voltage has been detected on the DXBUS CANH line. 2. Communication is not possible using the CANH wire. 3. Hazard lights were turned on when the DX System was turned on. Action: < Check the continuity of the DXBUS cable. < Check for shorts between DXBUS pins. An open or short circuit on another DX module can cause this fault. < If the Hazard Lights were already switched on when the DX System was turned on, Flash Code 10 and Limp Mode (slow driving) may result. To clear this fault, turn the Hazard Lights off, then turn the DX System off then on again.
11	11	**Stall Timeout Fault** Cause: The servo motor current has been at or close to current limit for longer than the Stall Timeout parameter value. Action: < Turn the DX System off then on again.

8.3 PCD Diagnostics

The PCD (Programming Configuration Diagnostic) tool can be used to provide diagnostics for the SLM.

To view diagnostics :

1. Enter the PCD's Main Menu screen as described in the PCD Manual.

2. Select ‘Diagnose Faults’.

   The PCD displays the following menu :

   Status Report
   Fault History
   Erase Fault History
   Print Fault History
   Terminal Emulation

8.3.1 Status Report

To view the Status Report :

1. Perform steps 1. and 2. above.

2. Select ‘Status Report’.

3. From the ‘Modules Attached’ menu, select ‘SLM’.

8.3.2 Fault History

To view the Fault History :

1. Enter the PCD's Main Menu screen as described in the PCD Manual.

2. Select ‘Diagnose Faults’.

3. Select ‘Fault History’.

4. From the ‘Modules Attached’ menu, select ‘SLM’.

Below are listed the Fault History codes and probable causes of these faults. If the suggested action does not remove the fault, contact a Dynamic Sales and Service Centre (refer to section 12).

Message	Possible Cause and Action
CPU / General Fault	Cause : Internal Fault Action: < Replace SLM. < Consult an approved Dynamic Service Agent.
Hall / Overtemp / ADC Fault	Cause: Internal Fault Action: < Replace SLM. < Consult an approved Dynamic Service Agent.
Relay / Precharge Fault	Cause : 1. Short between a motor terminal and Battery +. 2. Internal Fault Action: < Repair fault if found. < Consult an approved Dynamic Service Agent.
Port Feedback Fault	Cause: Internal Fault Action: < Consult an approved Dynamic Service Agent.
Motor Summation Fault	Cause : 1. External motor terminal short circuit. 2. A short circuit between a motor terminal and: a battery terminal, a Position Sense Pot terminal, or a clutch switch terminal. Action : < Check for the above and repair if necessary.

Message	Fault and Possible Cause
Steering Fault	Cause : 1. Position Sense Pot may have mechanical fault such as the pot turning or the shaft slipping. 2. Clutch may be slipping. 3. The steering may be excessively loaded. 4. Incorrect motor speed calibration. Action : < Check the Position Sense Pot for mechanical failure. < Ensure that the clutch is properly engaged < Ensure that there is nothing impeding the movement of the steering wheels. < Recalibrate SLM using an HHP.
Pot Wiper Voltage	Cause : 1. The Position Sense Pot Wiper may be open circuit. 2. The Position Sense Pot Wiper may be shorted to: a battery terminal, an end terminal on the pot, the clutch switch, or a motor terminal. 3. Faulty Pot. Action : < Check for the above and repair if necessary. < Check voltage on Position Sense Pot + end terminal.
Pot Res Fault	Cause : 1. A Position Sense Pot end terminal may be open circuit. 2. Any Position Sense Pot terminal may be shorted to: a battery terminal, another terminal on the pot, the clutch switch, or a motor terminal. 3. Faulty Pot. 4. Incorrect setting of Pot End Min. Voltage Or Pot End Max. Voltage Action : < Check for the above and repair if necessary. < Check voltage on Position Sense Pot + end terminal. < Correct programming and reprogram chair.
Motor O/C Fault	Cause : Servo motor or wiring may be open circuit. Action : < Check motor and wiring.

Message	Fault and Possible Cause
Stall Timeout Fault	Cause : The servo motor current has been at or close to current limit for longer than the Stall Timeout parameter value. Action : < Turn the DX System off then on again. Allow to cool down if necessary. < Check that steering wheels can turn freely.
Battery Low	Cause : The battery voltage is less than 17 V Action : < Recharge or replace battery.
Battery High	Cause : The battery voltage is greater than 32 V Action : < Check that battery charger is operating correctly. < May be caused by continuous braking down a hill at too higher speed. The problem will occur when batteries are fully charged, fully discharged or worn out.
Lighting SMPS Fault	Cause : 1. A short circuit between the 13.4 V regulated supply (if fitted) and battery + or -. 2. There is no power supplied to the lighting. Action : < Check all lighting circuitry. < Check wiring as per section 5.4.3 and 5.4.4.
Head Light Fault	Cause : The circuitry for the Side Lights (front and rear) is faulty. Action : < Check for an open circuit, or a short circuit from the Side Lights to battery + or -. < Check for blown headlight bulbs.
Left Indicator Fault	Cause : The circuitry for the Left Indicator Light is faulty. Action : < Check for an open circuit, or a short circuit from the Left Indicator Light to battery + or - < Check for blown left indicator bulbs.
Right Indicator Fault	Cause : The circuitry for the Right Indicator Light is faulty. Action : < Check for an open circuit, or a short circuit from the Right Indicator Light to battery + or -. < Check for blown right indicator bulbs.

9 Maintenance

1. The DX System should be regularly checked for integrity. Loose, damaged or corroded connectors or terminals, or damaged cabling should be replaced.

2. All switchable functions on the DX System should be regularly tested to ensure they function correctly.

3. All DX system components should be kept free of dust, dirt and liquids. If necessary wipe with a cloth dampened with warm water or alcohol. **Do not** use solvents or abrasive cleaners.

4. Where any doubt exists, consult your nearest Service Centre or Agent.

5. There are no user-serviceable parts in any DX System component - do not attempt to open any case.

Warning If any DX component is damaged in any way, or if internal damage may have occurred (for example by being dropped), have it checked by qualified personnel before operating

10 Safety and Misuse Warnings

All warnings throughout this Installation Manual must be read and understood. If in doubt ask for advice.

This DX component must not be used other than in the manner described in this Installation Manual.

The completed installation must be thoroughly checked, and all programmable options must be correctly adjusted for safe operation prior to use.

Pass on to user:

A warning must be conveyed to the wheelchair user that the controller could cause the chair to come to a sudden stop. In situations where this may affect the safety of the user, this will require the fitting and wearing of a seat belt.

The DX control system is fully programmable to optimise performance and safety. Do not operate the wheelchair unless you have full control. Ensure that the chair is correctly programmed for your needs and environment and ask your dealer to adjust if necessary. Always choose a Drive Program that you feel safe with and that is compatible with your environment.

Do not operate the DX System if it behaves erratically, or shows abnormal response heating, smoke or arcing. Turn the system off, disconnect the battery or open the battery overload switch, and consult your Service Agent.

Do not operate the DX System if the battery is nearly flat as a dangerous situation may result due to loss of power in an inopportune place.

Ensure the controller is turned off when not in use.

No connector pins should be touched, as contamination or damage due to electrostatic discharge may result. Dummy sockets in unused DXBUS connectors should be left in place unless a new module is added to the system.

Report any malfunctions immediately to your Service Agent.

11 Warranty

All equipment supplied by Dynamic Controls Ltd is warranted by the company to be free from faulty materials or workmanship. If any defect is found within 15 months (three months allowable for shelf life) of the date of purchase, the company will repair the equipment, or at its discretion, replace the equipment without charge for materials and labour.

The Warranty is subject to the provisions that the equipment:

- Has been correctly installed.
- Has been used solely in accordance with this manual.
- Has been properly connected to a suitable power supply in accordance with this manual.
- Has not been subjected to misuse or accident, or been modified or repaired by any person other than someone authorised by Dynamic Controls Ltd.
- Has been used solely for the driving of electrically powered wheelchairs in accordance with the wheelchair manufacturer's recommendations.

12 Sales and Service Information

For Sales and Service advice, or in case of any difficulty, please contact:

Head Office

Dynamic Controls Limited
Print Place
Christchurch
New Zealand

Telephone: Int. 64 3 338 0016
Fax: Int. 64 3 338 3283

Australia

Electronic Mobile Service (EMS)
46 Berripa Close
North Ryde, Sydney
NSW Australia 2113

Telephone: Int. 61 2 887 2824
24 hours: Int. 61 2 963 1778
Fax: Int. 61 2 887 2114

North America

Rosstron Inc
1521 W. 259th St
Harbor City, CA 90710
USA

Telephone: Int. 1 310 539 6293
Fax: Int. 1 310 539 4078

Europe

Controls Dynamic Ltd
Lisle Avenue
Kidderminster
DY11 7DL
United Kingdom

Telephone Int. 44 1562 820 055
Fax: Int. 44 1562 742 720

Note : The controller should be clearly labelled with the manufacturer's service agent's telephone number.